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## Not just a sum of its parts: How tasks of the theory of mind scale relate to executive function across time



Ceymi Doenyas<sup>a</sup>, H. Melis Yavuz<sup>b</sup>, Bilge Selcuk<sup>a,\*</sup>

<sup>a</sup> Department of Psychology, Koç University, Sariyer 34450, Istanbul, Turkey

<sup>b</sup> Department of Psychology, MEF University, Sariyer 34396, Istanbul, Turkey

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### ABSTRACT

There is a well-established relationship between theory of mind (ToM) and executive function (EF) during the preschool years. However, less is known about the concurrent and longitudinal relations between EF and specific tasks tapping different aspects of ToM. The current study investigated the ToM-EF relationship across 1 year in 3- to 5-year-old Turkish children using the ToM battery of Wellman and Liu (2004), which measures understanding of diverse desires (DD), diverse beliefs (DB), knowledge access (KA), contents false belief (CFB), explicit false belief (EFB), and hidden emotion (HE). This battery has not yet been used in its entirety to test the predictive relations between ToM and EF. We used peg-tapping and day-night tasks to measure EF. Our sample comprised 150 Turkish preschool children (69 girls) aged 36–60 months at Time 1 (T1) and 49–73 months at Time 2 (T2). Using the ToM composite with all six tasks, when child's age, receptive language, and T1 ability level (EF or ToM) were controlled, T1 EF significantly predicted T2 ToM, whereas T1 ToM did not predict T2 EF. Among DD, DB, KA, false belief understanding (FBU: the composite score of CFB and EFB), and HE, only KA and FBU were significantly associated with EF at T1 and T2. Further regression analyses showed that KA did not have a predictive relationship with EF. Instead, FBU drove the predictive EF–ToM relationship across time. Thus, in Turkish children, earlier EF predicts later ToM, but especially the FBU component, in this well-validated battery.

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\* Corresponding author.

E-mail address: [bselcuk@ku.edu.tr](mailto:bselcuk@ku.edu.tr) (B. Selcuk).

## Introduction

Cognitive abilities that enable the control of one's own thoughts and the understanding of others' minds have been a topic of contemplation in various fields of knowledge from philosophy to psychology. Theory of mind (ToM) and executive function (EF) are two of the cognitive abilities that are critical for healthy development and functioning. ToM is the ability to understand mental states, to perceive the thoughts and feelings of others, and to see how such mental states guide behavior (Peterson, Wellman, & Liu, 2005). EF, sometimes referred to as cognitive control, is the ability to exert control over cognition, attention, and behavioral tendencies through inhibitory control, cognitive flexibility or shifting, and working memory (Blair, Zelazo, & Greenberg, 2005; Diamond, 2013). ToM and EF abilities help children to navigate their social worlds successfully (Riggs, Jahromi, Razza, Dillworth-Bart, & Mueller, 2006), and difficulties in these skills predict a range of problems including social difficulties (Hughes, Dunn, & White, 1998).

There is a significant relation between ToM and EF starting from the preschool years, when important advances occur in both abilities (Anderson, 2002; Wellman, 2014). This relation persists beyond age, sex, language, and intelligence (Carlson, Mandell, & Williams, 2004; Hughes, 1998b; Müller, Liebermann-Finestone, Carpendale, Hammond, & Bibok, 2012) and is observed in children from different cultures such as American (Carlson, Moses, & Breton, 2002), British (Hughes, 1998a), Chinese (Sabbagh, Xu, Carlson, Moses, & Lee, 2006), and Iranian (Shahaeian, Henry, Razmjoe, Teymoori, & Wang, 2015) children. A meta-analysis of 102 studies with 3- to 6-year-old participants from 15 countries revealed a medium to large weighted mean effect size of .38 for the ToM-EF link, which is similar in size in the United States, United Kingdom, Canada, Australia/New Zealand, Continental Europe, and East Asia (Devine & Hughes, 2014).

Longitudinal studies using composites of various tasks to measure ToM and EF have investigated which construct developmentally predicts the other, and most evidence points to a causal direction from early EF abilities to later ToM understanding (Carlson et al., 2004; Devine & Hughes, 2014; Flynn, 2007; Hughes & Ensor, 2007; Marcovitch et al., 2015; Müller et al., 2012), with few studies finding a relation between early ToM and later EF (e.g., McAlister & Peterson, 2013). Because these studies used different tasks from each other, a logical next step to such studies is using a comprehensive ToM battery that has been validated across various samples and countries. Although the tasks of this battery have been used across cultures to scale the development of ToM in American (Wellman & Liu, 2004), Australian (Peterson & Wellman, 2009), Chinese (Wellman, Fang, & Peterson, 2011), and Iranian (Shahaeian, Peterson, Slaughter, & Wellman, 2011) children, and also to measure the ToM-EF relation at a single point in time (see, e.g., Duh et al., 2016, using the six tasks in this battery with Chinese preschool children), they have never been used in their entirety to examine the longitudinal relationship between ToM and EF in any culture. Moreover, these studies did not look at predictive relationships between different ToM components and EF. Understanding which components of ToM, among the comprehensive ToM concept, relate to EF concurrently and longitudinally is an interesting question that can be addressed using the six tasks in this battery that have been validated across samples and countries. In the current study, we investigated the ToM-EF relationship in Turkish children at two time points 1 year apart using the six-task ToM battery of Wellman and Liu (2004) and explored which component(s) of ToM drives the well-established relationship between ToM and EF.

## Accounts of the ToM-EF relationship

There are four major accounts put forth to explain the ToM-EF relationship, namely that (a) they have a common underlying capacity, (b) developments in ToM contribute to advances in EF, (c) EF is involved in the expression of ToM, and (d) EF is involved in the emergence of ToM (Moses & Tahiroglu, 2010). Whereas the first account does not have any predictions for which construct developmentally precedes the other, the second account assumes ToM precedence and the fourth account proposes EF precedence. For the third account, because ToM understanding cannot be measured before the development of EF, the experimental predictions of these accounts are more nuanced and mainly involve manipulations of cognitive load posed by ToM tasks.

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